Two Auxiliary Tables for the Solution of Kepler's Problem.

By A. Marth.

If e denotes the eccentricity, ϵ and μ the eccentric and mean anomaly, the multiplication of Kepler's equation

$$\epsilon - \mu = e \sin \epsilon \text{ by } \frac{\sin(\epsilon-\mu)}{\epsilon-\mu}$$

gives the equivalent equation

$$\tan \epsilon = \frac{\sin \mu}{\cos \mu - e \cdot \frac{\sin(\epsilon-\mu)}{\epsilon-\mu}}.$$

But

$$\frac{\sin(\epsilon-\mu)}{\epsilon-\mu} = \frac{\sin(e \sin \epsilon)}{e \sin \epsilon}$$

$$= 1 - \frac{e^2 \sin^2\epsilon}{6} + \frac{e^4 \sin^4\epsilon}{120} - \frac{e^6 \sin^6\epsilon}{5040} + \frac{e^8 \sin^8\epsilon}{362880} - \frac{e^{10} \sin^{10}\epsilon}{39916800} + \ldots$$

$$= 1 - e^2 \sin^2\epsilon \cdot \nu$$

if

$$\nu = \frac{1}{6}\left(1 - \frac{e^2 \sin^2\epsilon}{20} + \frac{e^4 \sin^4\epsilon}{840} - \frac{e^6 \sin^6\epsilon}{60480} + \frac{e^8 \sin^8\epsilon}{6652800} - \ldots\right)$$

Hence

$$\tan \epsilon = \frac{\sin \mu}{\cos \mu - e + e^3 \cdot \sin^2\epsilon \cdot \nu}.$$

This is the formula which I considered the most suitable for finding tan ϵ, and which would have appeared in the paper published on p. 511 of the last number of the *Monthly Notices*, accompanied by the first of the following tables, had not some doubts, which I may be allowed to explain, induced me to make some alterations in the proof-sheet and to defer the publication of the table.

Not having had, or having missed, the opportunity of seeing Oppolzer's table in vol. 50 of the *Denkschriften* of the Vienna Academy till shortly before the last meeting of the Royal Astronomical Society, I was surprised to find that his table, giving the values of

$$\log \frac{E-M}{\sin(E-M)} \text{ or } \log \lambda$$

for solving Kepler's equation in the form

$$tg\,(E-M) = \frac{e \sin M}{\lambda - e \cos M},$$

fills not less than 55 quarto pages, though it does not extend beyond $\log \tan (E-M) = 9{\cdot}800$ or $E-M = 32^\circ\ 15'$, which is, indeed, sufficient for the orbits of the minor planets, but leaves considerable portions of the orbits of the periodical comets unprovided for. I should have expected that Oppolzer would have preferred a table of a few pages only, furnishing

$$\log \frac{\lambda - 1}{tg^2 (E-M)}$$

or (say) $\log f$ for solving the equation in the form

$$tg\,(E-M) = \frac{e \sin M}{(1-\cos M) + tg^2 (E-M) \,.\, f},$$

the application of which in the second and succeeding approximations would not give more trouble than that of the adopted form.

However, as my own preference might be only an individual one, and as the question of advantages and disadvantages could not well be settled without a number of numerical applications, for which, in the absence of the second of the following tables, there was no time, I deferred my decision which table to give, and made the alteration in the proof-sheet, which, however desirous not to prejudge the question, I need not have made.

I now give two tables, the second (p. 537) containing the values of $\log \frac{e \sin \epsilon}{\sin (e \sin \epsilon)}$ or (adopting Oppolzer's letter λ instead of the ν on p. 151) $\log \lambda$ for finding $\tan \epsilon$ by means of the equation

$$\tan \epsilon = \frac{\sin \mu}{\cos \mu - \frac{e}{\lambda}} = \frac{\lambda \sin \mu}{\lambda \cos \mu - e},$$

while the first table (p. 532) supplies the values of $\log \nu$ (as defined before) for finding ϵ either by means of the equation

$$\tan \epsilon = \frac{\sin \mu}{(\cos \mu - e) + e^3 \,.\, \sin^2 \epsilon \,.\, \nu},$$

or, if preferred, by means of the equations

$$\gamma \sin \epsilon_1 = \sin \mu$$

$$\gamma \cos \epsilon_1 = \cos \mu - e$$

$$\sin (\epsilon - \epsilon_1) = -\frac{e^3}{\gamma} \,.\, \sin^3 \epsilon \,.\, \nu.$$

The first table is applicable for all eccentricities, for which the eccentric anomaly is employed. The second table is not given beyond the argument

$$\log (e \sin \epsilon) = 9{\cdot}880, \text{ or } \epsilon - \mu = 43^\circ.46.$$

The logarithms of ν and λ have been computed by means of the series

$$\log \nu = \log \frac{1}{6} - \frac{m}{20} \cdot e^2 \sin^2\epsilon - \frac{m}{16800} \cdot e^4 \sin^4\epsilon \qquad (m \text{ modulus})$$

$$+ \frac{m}{756000} \cdot e^6 \sin^6\epsilon + \frac{89\,m}{3104640000} e^8 \sin^8\epsilon + \ldots$$

$$\log \lambda = \frac{m}{6} \cdot e^2 \sin^2\epsilon + \frac{m}{180} \cdot e^4 \sin^4\epsilon + \frac{m}{2835} \cdot e^6 \sin^6\epsilon + \frac{m}{37800} \cdot e^8 \sin^8\epsilon$$

$$+ \frac{m}{467775} e^{10} \sin^{10}\epsilon + \frac{691\,m}{383107725^0} \cdot e^{12} \sin^{12}\epsilon + \ldots$$

Table I.: log ν.

$$\tan \epsilon = \frac{\sin \mu}{(\cos \mu - e) + e^3 \cdot \sin^2 \epsilon \cdot \nu} \quad \text{or} \quad \begin{aligned} \gamma \sin \epsilon_1 &= \sin \mu \\ \gamma \cos \epsilon_1 &= \cos \mu - e \\ \sin(\epsilon - \epsilon_1) &= -\frac{e^3}{\gamma} \cdot \sin^3 \epsilon \cdot \nu \end{aligned}$$

log (e sin ϵ)	log ν		log (e sin ϵ)	log ν		log (e sin ϵ)	log ν	
9·00	9·221 632	11	9·20	9·221 303	25	9·400	9·220 4785	126
·01	621	10	·21	278	27	·402	4659	128
·02	611	12	·22	251	29	·404	4531	130
·03	599	11	·23	222	29	·406	4401	130
·04	588	13	·24	193	31	·408	4271	131
·05	9·221 575	13	·25	9·221 162	32	9·410	9·220 4140	133
·06	562	13	·26	130	34	·412	4007	134
·07	549	14	·27	096	36	·414	3873	135
·08	535	15	·28	060	37	·416	3738	137
·09	520	15	·29	9·221 023	39	·418	3601	138
9·10	9·221 505	17	9·30	9·220 984	41	9·420	9·220 3463	139
·11	488	17	·31	943	42	·422	3324	140
·12	471	17	·32	901	45	·424	3184	142
·13	454	19	·33	856	47	·426	3042	143
·14	435	20	·34	809	49	·428	2899	144
·15	9·221 415	20	·35	9·220 760	51	9·430	9·220 2755	145
·16	395	21	·36	709	54	·432	2610	147
·17	374	23	·37	655	56	·434	2463	149
·18	351	23	·38	599	59	·436	2314	149
·19	328	25	·39	540	61	·438	2165	151
9·20	9·221 303		9·40	9·220 479		9·440	9·220 2014	

log (e sin ϵ)	log v			log (e sin ϵ)	log v			log (e sin ϵ)	log v		
9·440	9·220	2014	153	9·520	9·219	4675	221	9·600	9·218	4066	159
·442		1861	154	·522		4454	222	·601		3907	160
·444		1707	155	·524		4232	225	·602		3747	160
·446		1552	157	·526		4007	226	·603		3587	161
·448		1395	158	·528		3781	229	·604		3426	162
9·450	9·220	1237	159	9·530	9·219	3552	230	·605	9·218	3264	163
·452		1078	161	·532		3322	233	·606		3101	163
·454		0917	163	·534		3089	235	·607		2938	164
·458		0754	164	·536		2854	238	·608		2774	165
·458		0590	166	·538		2816	239	·609		2609	166
9·460	9·220	0424	167	9·540	9·219	2377	242	9·610	9·218	2443	167
·462	·220	0257	169	·542		2135	244	·611		2276	167
·464	·220	0088	170	·544		1891	246	·612		2109	168
·466	·219	9918	172	·546		1645	248	·613		1941	168
·468	·219	9746	173	·548		1397	251	·614		1773	170
9·470	9·219	9573	175	9·550	9·219	1146	253	·615	9·218	1603	170
·472		9398	177	·552		0893	255	·616		1433	171
·474		9221	178	·554		0638	258	·617		1262	172
·476		9043	180	·556		0380	260	·618		1090	173
·478		8863	182	·558	9·219	0120	263	·619		0917	173
9·480	9·219	8681	183	9·560	9·218	9857	265	9·620	9·218	0744	174
·482		8498	185	·562		9592	267	·621		0570	175
·484		8313	187	·564		9325	270	·622		0395	176
·486		8126	188	·566		9055	272	·623		0219	177
·488		7938	190	·568		8783	275	·624	9·218	0042	178
9·490	9·219	7748	192	9·570	9·218	8508	278	·625	9·217	9864	178
·492		7556	194	·572		8230	280	·626		9686	179
·494		7362	195	·574		7950	282	·627		9507	180
·496		7167	198	·576		7668	285	·628		9327	181
·498		6969	199	·578		7383	288	·629		9146	181
9·500	9·219	6770	201	9·580	9·218	7095	291	9·630	9·217	8965	183
·502		6569	203	·582		6804	293	·631		8782	183
·504		6366	204	·584		6511	296	·632		8599	184
·506		6162	207	·586		6215	299	·633		8415	185
·508		5955	208	·588		5916	301	·634		8230	186
9·510	9·219	5747	211	8·590	9·218	5615	304	·635	9·217	8044	187
·512		5536	212	·592		5311	307	·636		7857	188
·514		5324	215	·594		5004	310	·637		7669	188
·516		5109	216	·596		4694	313	·638		7481	189
·518		4893	218	·598		4381	315	·639		7292	190
9·520	9·219	4675		8·600	9·218	4066		9·640	9·217		

log ($e \sin \epsilon$)	log ν			log ($e \sin \epsilon$)	log ν			log ($e \sin \epsilon$)	log ν		
9·640	9·217	7102	191	9·680	9·216	8728	229	9·720	9·215	8661	277
·641		6911	192	·681		8499	231	·721		8384	277
·642		6719	193	·682		8268	232	·722		8107	279
·643		6526	194	·683		8036	233	·723		7828	280
·644		6332	195	·684		7803	234	·724		7548	281
·645	9·217	6137	195	·685	9·216	7569	235	·725	9·215	7267	283
·646		5942	197	·686		7334	236	·726		6984	284
·647		5745	197	·687		7098	237	·727		6700	285
·648		5548	198	·688		6861	239	·728		6415	287
·649		5350	199	·689		6622	239	·729		6128	288
9·650	9·217	5151	200	9·690	9·216	6383	241	9·730	9·215	5840	289
·651		4951	201	·691		6142	242	·731		5551	291
·852		4750	202	·692		5900	242	·732		5260	292
·653		4548	203	·693		5658	244	·733		4968	293
·654		4345	204	·694		5414	245	·734		4675	295
·655	9·217	4141	205	·695	9·216	5169	246	·735	9·215	4380	297
·656		3936	205	·696		4923	248	·736		4083	297
·657		3731	207	·697		4675	248	·737		3786	298
·658		3524	208	·698		4427	250	·738		3488	300
·659		3316	208	·699		4177	251	·739		3188	301
9·660	9·217	3108	210	9·700	9·216	3926	252	9·740	9·215	2887	303
·661		2898	210	·701		3674	253	·741		2584	305
·662		2688	212	·702		3421	254	·742		2279	305
·663		2476	212	·703		3167	255	·743		1974	307
·664		2264	214	·704		2912	257	·744		1667	309
·665	9·217	2050	214	·705	9·216	2655	258	·745	9·215	1358	310
·666		1836	215	·706		2397	259	·746		1048	311
·667		1621	217	·707		2138	260	·747		0737	313
·688		1404	217	·708		1878	261	·748		0424	314
·669		1187	218	·709		1617	263	·749	9·215	0110	316
9·670	9·217	0969	220	9·710	9·216	1354	264	9·750	9·214	9794	317
·671		0749	220	·711		1090	265	·751		9477	319
·672		0529	222	·712		0825	266	·752		9158	320
·673		0307	222	·713		0559	267	·753		8838	322
·674	9·217	0085	224	·714		0292	269	·754		8516	323
·675	9·216	9861	224	·715	9·216	0023	270	·755	9·214	8193	324
·676		9637	226	·716	9·215	9753	271	·755		7869	326
·677		9411	226	·717		9482	273	·757		7543	328
·678		9185	228	·718		9209	273	·758		7215	329
·679		8957	229	·719		8936	275	·759		6886	331
9·680	9·218	8728		9·720	9·215	8661		9·760	9·214	6555	

log(e sin ε)	log ν		log(e sin ε)	log ν		log(e sin ε)	log ν	
9·760	9·214 6555	332	9·800	9·213 1999	399	9·840	9·211 4496	480
·761	6223	334	·801	·213 1600	402	·841	·211 4016	483
·762	5889	335	·802	·213 1198	403	·842	·211 3533	485
·763	5554	337	·803	·213 0795	405	·843	·211 3048	487
·764	5217	338	·804	·213 0390	407	·844	·211 2561	489
·765	9·214 4879	340	·805	·212 9983	408	·845	·211 2072	491
·766	4539	341	·806	·212 9575	411	·846	·211 1581	494
·767	4198	343	·807	·212 9164	412	·847	·211 1087	496
·768	3855	345	·808	·212 8752	415	·848	·211 0591	498
·769	3510	346	·809	·212 8337	416	·849	·211 0093	501
9·770	9·214 3164	348	9·810	9·212 7921	418	9·850	9·210 9592	503
·771	2816	350	·811	·212 7503	420	·851	·210 9089	505
·772	2466	351	·812	·212 7083	423	·852	·210 8584	508
·773	2115	352	·813	·212 6660	424	·853	·210 8076	510
·774	1763	354	·814	·212 6236	426	·854	·210 7666	512
·775	9·214 1409	356	·815	·212 5810	428	·855	·210 7054	515
·776	1053	358	·816	·212 5382	430	·856	·210 6539	517
·777	0695	359	·817	·212 4952	432	·857	·210 6022	519
·778	9·214 0336	361	·818	·212 4520	434	·858	·210 5503	522
·779	·213 9975	363	·819	·212 4086	435	·859	·210 4981	524
9·780	9·213 9612	364	9·820	9·212 3651	438	9·860	9·210 4457	527
·781	9248	366	·821	·212 3213	440	·861	·210 3930	529
·782	8882	368	·822	·212 2773	442	·862	·210 3401	532
·783	8514	369	·823	·212 2331	445	·863	·210 2869	534
·784	8145	371	·824	·211 1886	446	·864	·210 2335	536
·785	9·213 7774	373	·825	·212 1440	448	·865	·210 1799	539
·786	7401	374	·826	·212 0992	450	·866	·210 1260	541
·787	7027	376	·827	·212 0542	452	·867	·210 0719	544
·788	6651	378	·828	·212 0090	455	·868	·210 0175	547
·789	6273	380	·829	·211 9635	456	·869	·209 9628	549
9·790	9·213 5893	381	9·830	9·211 9179	459	9·870	9·209 9079	551
·791	5512	383	·831	·211 8720	461	·871	·209 8528	554
·792	5129	385	·832	·211 8259	463	·872	·209 7974	557
·793	4744	387	·833	·211 7796	465	·873	·209 7417	559
·794	4357	388	·834	·211 7331	467	·874	·209 6858	562
·795	9·213 3869	391	·835	·211 6864	469	·875	·209 6296	564
·796	3578	392	·836	·211 6395	472	·876	·209 5732	567
·797	3186	394	·837	·211 5923	473	·877	·209 5165	570
·798	2792	395	·838	·211 5450	476	·878	·209 4595	572
·799	2397	398	·839	·211 4974	478	·879	·209 4023	575
9·800	9·213 1999		9·840	9·211 4496		9·880	9·209 3448	

log (e sin ϵ)	log ν		log (e sin ϵ)	log ν		log (e sin ϵ)	log ν	
9·880	9·209 3448	578	9·920	9·206 8137	695	9·960	9·203 7697	835
·881	·209 2870	580	·921	·206 7442	698	·961	·203 6862	840
·882	·209 2290	583	·922	·206 6744	701	·962	·203 6022	843
·883	·209 1707	586	·923	·206 6043	704	·963	·203 5179	847
·884	·209 1121	588	·924	·206 5339	707	·964	·203 4332	850
·885	·209 0533	591	·925	·206 4632	711	·965	·203 3482	855
·886	·208 9942	594	·926	·206 3921	714	·966	·203 2627	859
·887	·208 9348	596	·927	·206 3207	718	·967	·203 1868	863
·888	·208 8752	599	·928	·206 2489	720	·968	·203 0905	866
·889	·208 8153	602	·929	·206 1769	724	·969	·203 0039	871
9·890	9·208 7551	605	9·930	9·206 1045	728	9·970	9·202 9168	875
·891	·208 6946	608	·931	·206 0217	730	·971	·202 8293	879
·892	·208 6338	610	·932	·205 9587	734	·972	·202 7414	882
·893	·208 5728	613	·933	·205 8853	738	·973	·202 6532	887
·894	·208 5115	616	·934	·205 8115	741	·974	·202 5645	891
·895	·208 4499	619	·935	·205 7474	745	·975	·202 4754	895
·896	·208 3880	622	·936	·205 6629	747	·976	·202 3859	900
·897	·208 3258	625	·937	·205 5882	751	·977	·202 2959	903
·898	·208 2633	627	·938	·205 5131	755	·978	·202 2056	908
·899	·208 2006	631	·939	·205 4376	758	·979	·202 1148	912
9·900	9·208 1375	633	9·940	9·205 3618	761	9·980	9·202 0236	916
·901	·208 0742	636	·941	·205 2857	765	·981	·201 9320	920
·902	·208 0106	639	·942	·205 2092	769	·982	·201 8400	924
·903	·207 9467	643	·943	·205 1323	772	·983	·201 7476	929
·904	·207 8824	645	·944	·205 0551	776	·984	·201 6547	933
·905	·207 8179	648	·945	·204 9775	780	·985	·201 5614	938
·906	·207 7531	651	·946	·204 8995	783	·986	·201 4676	942
·907	·207 6880	654	·947	·204 8212	787	·987	·201 3734	946
·908	·207 6226	657	·948	·204 7425	790	·988	·201 2788	950
·909	·207 5569	660	·949	·204 6635	794	·989	·201 1838	955
9·910	9·207 4909	664	9·950	9·204 5841	798	9·990	9·201 0883	959
·911	·207 4245	666	·951	·204 5043	801	·991	·200 9924	964
·912	·207 3579	669	·952	·204 4242	805	·992	·200 8960	968
·913	·207 2910	673	·953	·204 3437	809	·993	·200 7992	973
·914	·207 2237	675	·954	·204 2628	812	·994	·200 7019	977
·915	·207 1562	679	·955	·204 1816	816	·995	·200 6042	982
·916	·207 0883	682	·956	·204 1000	820	·996	·200 5060	986
·917	·207 0201	685	·957	·204 0180	824	·997	·200 4074	991
·918	·206 9516	688	·958	·203 9356	828	·998	·200 3083	995
·919	·206 8828	691	·959	·203 8528	831	9·999	·200 2088	1000
9·920	9·206 8137		9·960	9·203 7697		0·000	9·200 1088	

$$\tan \epsilon = \frac{\sin \mu}{\cos \mu - \frac{e}{\lambda}}$$

Table II. : log λ.

log (e sin ϵ)	log λ			log (e sin ϵ)	log λ			log (e sin ϵ)	log λ		
7·6	·000	0011	7	8·60	·000	1147	54	8·85	·000	3628	85
7·7		0018	11	8·61		1201	57			3713	86
7·80	·000	0029	7	8·62		1258	59	8·86		3799	89
7·85		0036	10	8·63		1317	62			3888	90
7·90		0046	11	8·64		1379	65	8·87		3978	93
7·95		0057	15	8·65	·000	1444	68			4071	95
8·00		0072	19	8·66		1512	72	8·88		4166	97
8·05		0091	24	8·67		1584	74			4263	99
8·10	·000	0115	11	8·68		1658	78	8·89		4362	102
·12		0126	12	8·69		1736	82			4464	104
·14		0138	13	8·70	·000	1818	43	8·900	·000	4568	42
·16		0151	15			1861	43	·902		4610	43
·18		0166	16	8·71		1904	44	·904		4653	43
8·20	·000	0182	17			1948	46	·906		4696	43
·22		0199	20	8·72		1994	46	·908		4739	44
·24		0219	21			2040	48	8·910	·000	4783	45
·26		0240	23	8·73		2088	48	·912		4828	44
·28		0263	25			2136	50	·914		4872	45
8·30	·000	0288	28	8·74		2186	51	·916		4917	46
·32		0316	30			2237	52	·918		4963	46
·34		0346	34	8·75	·000	2289	53	8·920	·000	5009	46
·36		0380	37			2342	55	·922		5055	47
·38		0417	40	8·76		2397	56	·924		5102	47
8·40	·000	0457	44			2453	57	·926		5149	48
·42		0501	48	8·77		2510	59	·928		5197	48
·44		0549	53			2569	59	8·930	·000	5245	48
·46		0602	58	8·78		2628	62	·932		5293	49
·48		0660	64			2690	62	·934		5342	50
8·50	·000	0724	34	8·79		2752	64	·936		5392	50
8·51		0758	36			2816	66	·938		5442	50
8·52		0794	37	8·80	·000	2882	67	8·940	·000	5492	51
8·53		0831	39			2949	69	·942		5543	51
8·54		0870	41	8·81		3018	70	·944		5594	52
8·55		0911	43			3088	72	·946		5646	52
8·56		0954	45	8·82		3160	74	·948		5698	53
8·57		0999	47			3234	75	8·950	·000	5751	53
8·58		1046	50	8·83		3309	77	·952		5804	54
8·59		1096	51			3386	79	·954		5858	54
8·60	·000	1147		8·84		3465	81	·956		5912	55
						3546	82	·958		5967	55
				8·85	·000	3628		8·960	·000	6022	

log (e sin ϵ)	log λ		log (e sin ϵ)	log λ		log (e sin ϵ)	log λ	
8·960	·000 6022	56	9·040	·000 8706	80	9·120	·001 2586	116
·962	6078	56	·042	8786	82	·122	2702	118
·964	6134	57	·044	8868	82	·124	2820	119
·966	6191	57	·046	8950	83	·126	2939	120
·968	6248	58	·048	9033	83	·128	3059	120
8·970	·000 6306	58	9·050	·000 9116	85	9·130	·001 3179	122
·972	6364	59	·052	9201	85	·132	3301	124
·974	6423	60	·054	9286	86	·134	3425	124
·976	6483	60	·056	9372	87	·136	3549	125
·978	6543	60	·058	9459	87	·138	3674	127
8·980	·000 6603	61	9·060	·000 9546	88	9·140	·001 3801	128
·982	6664	62	·062	9634	90	·142	3929	129
·984	6726	62	·064	9724	90	·144	4058	130
·986	6788	63	·066	9814	90	·146	4188	131
·988	6851	64	·068	9904	92	·148	4319	133
8·990	·000 6915	64	9·070	·000 9996	93	9·150	·001 4452	134
·992	6979	64	·072	·001 0089	93	·152	4586	135
·994	7043	65	·074	0182	94	·154	4721	136
·996	7108	66	·076	0276	95	·156	4857	138
·998	7174	67	·078	0371	96	·158	4995	138
9·000	·000 7241	67	9·080	·001 0467	97	9·160	·001 5133	140
·002	7308	67	·082	0564	98	·162	5273	142
·004	7375	69	·084	0662	99	·164	5415	143
·006	7444	69	·086	0761	100	·166	5558	144
·008	7513	69	·088	0861	100	·168	5702	145
9·010	·000 7582	70	9·090	·001 0961	102	9·170	·001 5847	147
·012	7652	71	·092	1063	102	·172	5994	148
·014	7723	72	·094	1165	103	·174	6142	149
·016	7795	72	·096	1268	105	·176	6291	151
·018	7867	73	·098	1373	105	·178	6442	153
9·020	·000 7940	73	9·100	·001 1478	106	9·180	·001 6595	153
·022	8013	74	·102	1584	107	·182	6748	155
·024	8087	75	·104	1691	109	·184	6903	157
·026	8162	76	·106	1800	109	·186	7060	158
·028	8238	76	·108	1909	110	·188	7218	159
9·030	·000 8314	77	9·110	·001 2019	111	9·190	·001 7377	161
·032	8391	77	·112	2130	113	·192	7538	163
·034	8468	79	·114	2243	113	·194	7701	164
·036	8547	79	·116	2356	114	·196	7865	165
·038	8626	80	·118	2470	116	·198	8030	167
9·040	·000 8706		9·120	·001 2586		9·200	·001 8197	

log (*e* sin ϵ)		log λ	
9·200	·001	8197	84
·201		8281	84
·202		8365	85
·203		8450	85
·204		8535	86
·205	·001	8621	86
·206		8707	86
·207		8793	87
·208		8880	88
·209		8968	87
9·210	·001	9055	88
·211		9143	89
·212		9232	89
·213		9321	89
·214		9410	90
·215	·001	9500	90
·216		9590	90
·217		9680	91
·218		9771	91
·219		9862	92
9·220	·001	9954	92
·221	·002	0046	93
·222		0139	93
·223		0232	93
·224		0325	94
·225	·002	0419	95
·226		0514	95
·227		0609	95
·228		0704	96
·229		0800	96
9·230	·002	0896	96
·231		0992	97
·232		1089	97
·233		1186	98
·234		1284	99
·235	·002	1383	99
·236		1482	99
·237		1581	99
·238		1680	100
·239		1780	101
9·240	·002	1881	

log (*e* sin ϵ)		log λ	
9·240	·002	1881	101
·241		1982	102
·242		2084	102
·243		2186	102
·244		2288	103
·245	·002	2391	104
·246		2495	104
·247		2599	104
·248		2703	105
·249		2808	105
9·250	·002	2913	106
·251		3019	107
·252		3126	107
·253		3233	107
·254		3340	108
·255	·002	3448	108
·256		3556	109
·257		3665	109
·258		3774	110
·259		3884	111
9·260	·002	3995	111
·261		4106	111
·262		4217	112
·263		4329	112
·264		4441	113
·265	·002	4554	114
·266		4668	114
·267		4782	114
·268		4896	115
·269		5011	116
9·270	·002	5127	116
·271		5243	117
·272		5360	117
·273		5477	117
·274		5594	119
·275	·002	5713	119
·276		5832	119
·277		5951	120
·278		6071	120
·279		6191	121
9·280	·002	6312	

log (*e* sin ϵ)		log λ	
9·280	·002	6312	122
·281		6434	122
·282		6556	123
·283		6679	123
·284		6802	124
·285	·002	6926	124
·286		7050	125
·287		7175	126
·288		7301	126
·289		7427	127
9·290	·002	7554	127
·291		7681	128
·292		7809	129
·293		7938	129
·294		8067	130
·295	·002	8197	130
·296		8327	131
·297		8458	131
·298		8589	132
·299		8721	133
9·300	·002	8854	134
·301		8988	134
·302		9122	134
·303		9256	135
·304		9391	136
·305	·002	9527	137
·306		9664	137
·307		9801	138
·308	·002	9939	138
·309	·003	0077	139
9·310	·003	0216	140
·311		0356	140
·312		0496	141
·313		0637	142
·314		0779	142
·315	·003	0921	143
·316		1064	143
·317		1207	145
·318		1352	145
·319		1497	145
9·320	·003	1642	

log (e sin ϵ)	log λ		log (e sin ϵ)	log λ		log (e sin ϵ)	log λ	
9·320	·003 1642	146	9·360	·003 8053	176	9·400	·004 5767	211
·321	1788	147	·361	8229	177	·401	5978	213
·322	1935	148	·362	8406	178	·402	6191	214
·323	2093	148	·363	8584	178	·403	6405	214
·324	2231	149	·364	8762	179	·404	6619	216
·325	·003 2380	150	·365	·003 8941	180	·405	·004 6835	217
·326	2530	150	·366	9121	181	·406	7052	217
·327	2680	151	·367	9302	182	·407	7269	219
·328	2831	152	·368	9484	183	·408	7488	220
·329	2983	153	·369	9667	183	·409	7708	220
9·330	·003 3136	153	9·370	·003 9850	184	9·410	·004 7928	222
·331	3289	154	·371	·004 0034	186	·411	8150	223
·332	3443	154	·372	0220	186	·412	8373	224
·333	3597	156	·373	0406	186	·413	8597	224
·334	3753	156	·374	0592	188	·414	8821	226
·335	·003 3909	157	·375	·004 0780	189	·415	·004 9047	227
·336	4066	157	·376	0969	189	·416	9274	228
·337	4213	158	·377	1158	191	·417	9502	229
·338	4381	159	·378	1349	191	·418	9731	230
·339	4540	160	·379	1540	192	·419	·004 9961	231
9·340	·003 4700	160	9·380	·004 1732	193	9·420	·005 0192	233
·341	4860	161	·381	1925	194	·421	0425	233
·342	5021	162	·382	2119	195	·422	0658	234
·343	5183	163	·383	2314	195	·423	0892	236
·344	5346	164	·384	2509	197	·424	1128	236
·345	·003 5510	164	·385	·004 2706	197	·425	·005 1364	238
·346	5674	164	·386	2903	199	·426	1602	239
·347	5838	166	·387	3102	199	·427	1841	240
·348	6004	167	·388	3301	200	·428	2081	241
·349	6171	167	·389	3501	202	·429	2322	242
9·350	·003 6338	168	9·390	·004 3703	202	9·430	·005 2564	243
·351	6506	169	·391	3905	203	·431	2807	244
·352	6675	169	·392	4108	204	·432	3051	246
·353	6844	171	·393	4312	205	·433	3297	246
·354	7015	171	·394	4517	206	·434	3543	248
·355	·003 7186	172	·395	·004 4723	207	·435	·005 3791	249
·356	7358	173	·396	4930	207	·436	4040	250
·357	7531	173	·397	5137	209	·437	4290	251
·358	7704	174	·398	5346	210	·438	4541	253
·359	7878	175	·399	5556	211	·439	4794	253
9·360	·003 8053		9·400	·004 5767		9·440	·005 5047	

log (e sin ϵ)	log λ		log (e sin ϵ)	log λ		log (e sin ϵ)	log λ	
9·440	·005 5047	255	9·480	·006 6215	307	9·520	·007 9658	369
·441	·005 5302	256	·481	·006 6522	308	·521	·008 0027	371
·442	·005 5558	257	·482	·006 6830	309	·522	·008 0398	372
·443	·005 5815	258	·483	·006 7139	311	·523	·008 0770	374
·444	·005 6073	260	·484	·006 7450	313	·524	·008 1144	376
·445	·005 6333	260	·485	·006 7763	313	·525	·008 1520	378
·446	·005 6593	262	·486	·006 8076	315	·526	·008 1898	380
·447	·005 6855	263	·487	·006 8391	317	·527	·008 2178	381
·448	·005 7118	265	·488	·006 8708	318	·528	·008 2659	383
·449	·005 7383	265	·489	·006 9026	320	·529	·008 3042	385
9·450	·005 7648	267	9·490	·006 9346	321	9·530	·008 3427	386
·451	·005 7915	268	·491	·006 9667	323	·531	·008 3813	388
·452	·005 8183	270	·492	·006 9990	324	·532	·008 4201	391
·453	·005 8453	270	·493	·007 0314	326	·533	·008 4592	392
·454	·005 8723	272	·494	·007 0640	327	·534	·008 4984	394
·455	·005 8995	273	·495	·007 0967	328	·535	·008 5378	395
·456	·005 9268	274	·496	·007 1295	330	·536	·008 5773	398
·457	·005 9542	276	·497	·007 1625	332	·537	·008 6171	399
·458	·005 9818	277	·498	·007 1957	333	·538	·008 6570	401
·459	·006 0095	278	·499	·007 2290	335	·539	·008 6971	403
9·460	·006 0373	279	9·500	·007 2625	337	9·540	·008 7374	405
·461	·006 0652	281	·501	·007 2962	338	·541	·008 7779	407
·462	·006 0933	282	·502	·007 3300	339	·542	·008 8186	409
·463	·006 1215	283	·503	·007 3639	341	·543	·008 8595	410
·464	·006 1498	285	·504	·007 3980	343	·544	·008 9005	413
·465	·006 1783	286	·505	·007 4323	344	·545	·008 9418	414
·466	·006 2069	287	·506	·007 4667	346	·546	·008 9832	417
·467	·006 2356	289	·507	·007 5013	347	·547	·009 0249	418
·468	·006 2645	290	·508	·007 5360	349	·548	·009 0667	420
·469	·006 2935	291	·509	·007 5709	351	·549	·009 1087	423
9·470	·006 3226	293	9·510	·007 6060	352	9·550	·009 1510	424
·471	·006 3519	294	·511	·007 6412	354	·551	·009 1934	426
·472	·006 3813	296	·512	·007 6766	356	·552	·009 2360	428
·473	·006 4109	297	·513	·007 7122	357	·553	·009 2788	430
·474	·006 4406	298	·514	·007 7479	359	·554	·009 3218	432
·475	·006 4704	299	·515	·007 7838	361	·555	·009 3650	434
·476	·006 5003	301	·516	·007 8199	362	·556	·009 4084	437
·477	·006 5304	302	·517	·007 8561	364	·557	·009 4521	438
·478	·006 5606	304	·518	·007 8925	366	·558	·009 4959	440
·479	·006 5910	305	·519	·007 9291	367	·559	·009 5399	442
9·480	·006 6215		9·520	·007 9658		9·560	·009 5841	

log ($e \sin \epsilon$)	log λ		log ($e \sin \epsilon$)	log λ		log ($e \sin \epsilon$)	log λ	
9·560	·009 5841	445	9·600	·011 5331	267	9·620	·012 6523	293
·561	·009 6286	446		·011 5598	268		·012 6816	294
·562	·009 6732	449	·601	·011 5866	268	·621	·012 7110	295
·563	·009 7181	450		·011 6134	269		·012 7405	296
·564	·009 7631	453	·602	·011 6403	270	·622	·012 7701	296
·565	·009 8084	455		·011 6673	271		·012 7997	297
·566	·009 8539	457	·603	·011 6944	271	·623	·012 8294	297
·567	·009 8996	459		·011 7215	272		·012 8591	298
·568	·009 9455	461	·604	·011 7487	272	·624	·012 8889	299
·569	·009 9916	463		·011 7759	273		·012 9188	300
9·570	·010 0379	466	·605	·011 8032	273	·625	·012 9488	300
·571	·010 0845	468		·011 8305	275		·012 9788	301
·572	·010 1313	469	·606	·011 8580	275	·626	·013 0089	302
·573	·010 1782	472		·011 8855	275		·013 0391	302
·574	·010 2254	475	·607	·011 9130	276	·627	·013 0693	303
·575	·010 2729	476		·011 9406	277		·013 0996	304
·576	·010 3205	479	·608	·011 9683	277	·628	·013 1300	305
·577	·010 3684	481		·011 9960	278		·013 1605	305
·578	·010 4165	483	·609	·012 0238	279	·629	·013 1910	306
·579	·010 4648	485		·012 0517	279		·013 2216	307
9·580	·010 5133	488	9·610	·012 0796	280	9·630	·013 2523	307
·581	·010 5621	490		·012 1076	281		·013 2830	308
·582	·010 6111	492	·611	·012 1357	282	·631	·013 3138	309
·583	·010 6603	494		·012 1639	282		·013 3447	309
·584	·010 7097	497	·612	·012 1921	282	·632	·013 3756	311
·585	·010 7594	499		·012 2203	284		·013 4067	311
·586	·010 8093	502	·613	·012 2487	284	·633	·013 4378	311
·587	·010 8595	504		·012 2771	284		·013 4689	313
·588	·010 9099	506	·614	·012 3055	285	·634	·013 5002	313
·589	·010 9605	508		·012 3340	286		·013 5315	314
9·590	·011 0113	511	·615	·012 3626	287	·635	·013 5629	315
·591	·011 0624	513		·012 3913	287		·013 5944	315
·592	·011 1137	516	·616	·012 4200	288	·636	·013 6259	316
·593	·011 1653	518		·012 4488	289		·013 6575	317
·594	·011 2171	521	·617	·012 4777	289	·637	·013 6892	318
·595	·011 2692	523		·012 5066	290		·013 7210	318
·596	·011 3215	525	·618	·012 5356	291	·638	·013 7528	319
·597	·011 3740	528		·012 5647	291		·013 7847	320
·598	·011 4268	530	·619	·012 5938	292	·639	·013 8167	320
·599	·011 4798	533		·012 6230	293		·013 8487	223
9·600	·011 5331		9·620	·012 6523		9·640	·013 8809	

log (e sin ϵ)	log λ	
9·640	·013 8809	322
	·013 9131	323
·641	·013 9454	323
	·013 9777	324
·642	·014 0101	325
	·014 0426	326
·643	·014 0752	326
	·014 1078	328
·644	·014 1406	328
	·014 1734	329
·645	·014 2063	330
	·014 2393	330
·646	·014 2723	332
	·014 3055	332
·647	·014 3387	332
	·014 3719	334
·648	·014 4053	334
	·014 4387	335
·649	·014 4722	336
	·014 5058	337
9·650	·014 5395	337
	·014 5732	338
·651	·014 6070	339
	·014 6409	340
·652	·014 6749	341
	·014 7090	341
·653	·014 7431	343
	·014 7774	343
·654	·014 8117	343
	·014 8460	345
·655	·014 8805	345
	·014 9150	347
·656	·014 9497	347
	·014 9844	347
·657	·015 0191	349
	·015 0540	350
·658	·015 0890	350
	·015 1240	351
·659	·015 1591	352
	·015 1943	353
9·660	·015 2296	

log (e sin ϵ)	log λ	
9·660	·015 2296	353
	·015 2649	355
·661	·015 3004	355
	·015 3359	356
·662	·015 3715	357
	·015 4072	358
·663	·015 4430	358
	·015 4788	360
·664	·015 5148	360
	·015 5508	361
·665	·015 5869	362
	·015 6231	363
·666	·015 6594	363
	·015 6957	365
·667	·015 7322	365
	·015 7687	366
·668	·015 8053	367
	·015 8420	368
·669	·015 8788	369
	·015 9157	370
9·670	·015 9527	370
	·015 9797	371
·671	·016 0268	373
	·016 0641	373
·672	·016 1014	374
	·016 1388	375
·673	·016 1763	375
	·016 2138	377
·674	·016 2515	377
	·016 2892	379
·675	·016 3271	379
	·016 3650	380
·676	·016 4030	381
	·016 4411	382
·677	·016 4793	383
	·016 5176	384
·678	·016 5560	384
	·016 5944	386
·679	·016 6330	386
	·016 6716	387
9·680	·016 7103	

log (e sin ϵ)	log λ	
9·680	·016 7103	389
	·016 7492	389
·681	·016 7881	390
	·016 8271	391
·682	·016 8662	392
	·016 9054	393
·683	·016 9447	393
	·016 9840	395
·684	·017 0235	395
	·017 0630	397
·685	·017 1027	397
	·017 1424	399
·686	·017 1823	399
	·017 2222	400
·687	·017 2622	401
	·017 3023	402
·688	·017 3425	403
	·017 3828	404
·689	·017 4232	405
	·017 4637	406
9·690	·017 5043	407
	·017 5450	408
·691	·017 5858	409
	·017 6267	409
·692	·017 6676	411
	·017 7087	412
·693	·017 7499	412
	·017 7911	414
·694	·017 8325	414
	·017 8739	416
·695	·017 9155	416
	·017 9571	418
·696	·017 9989	418
	·018 0407	419
·697	·018 0826	421
	·018 1247	421
·698	·018 1668	422
	·018 2090	424
·699	·018 2514	424
	·018 2938	425
9·700	·018 3363	

log ($e \sin \epsilon$)	log λ		log ($e \sin \epsilon$)	log λ		log ($e \sin \epsilon$)	log λ	
9·700	·018 3363	427	9·720	·020 1221	468	9·740	·022 0835	514
	·018 3790	427		·020 1689	469		·022 1349	516
·701	·018 4217	428	·721	·020 2158	471	·741	·022 1865	517
	·018 4645	430		·020 2629	471		·022 2382	518
·702	·018 5075	430	·722	·020 3100	473	·742	·022 2900	519
	·018 5505	432		·020 3573	474		·022 3419	520
·703	·018 5937	432	·723	·020 4047	475	·743	·022 3939	522
	·018 6369	433		·020 4522	476		·022 4461	523
·704	·018 6802	435	·724	·020 4998	477	·744	·022 4984	524
	·018 7237	435		·020 5475	478		·022 5508	525
·705	·018 7672	437	·725	·020 5953	479	·745	·022 6033	527
	·018 8109	437		·020 6432	481		·022 6560	528
·706	·018 8546	438	·726	·020 6913	481	·746	·022 7088	529
	·018 8984	440		·020 7394	483		·022 7617	530
·707	·018 9424	441	·727	·020 7877	484	·747	·022 8147	532
	·018 9865	441		·020 8361	485		·022 8679	533
·708	·019 0306	443	·728	·020 8846	486	·748	·022 9212	534
	·019 0749	443		·020 9332	487		·022 9746	535
·709	·019 1192	445	·729	·020 9819	489	·749	·023 0281	537
	·019 1637	446		·021 0308	490		·023 0818	538
9·710	·019 2083	447	9·730	·021 0798	490	9·750	·023 1356	539
	·019 2530	447		·021 1288	492		·023 1895	540
·711	·019 2977	449	·731	·021 1780	493	·751	·023 2435	542
	·019 3426	450		·021 2273	494		·023 2977	543
·712	·019 3876	451	·732	·021 2767	496	·752	·023 3520	544
	·019 4327	452		·021 3263	496		·023 4064	546
·713	·019 4779	453	·733	·021 3759	498	·753	·023 4610	546
	·019 5232	455		·021 4257	499		·023 5156	548
·714	·019 5687	455	·734	·021 4756	500	·754	·023 5704	550
	·019 6142	456		·021 5256	501		·023 6254	551
·715	·019 6598	458	·735	·021 5757	503	·755	·023 6805	552
	·019 7056	458		·021 6260	503		·023 7357	553
·716	·019 7514	460	·736	·021 6763	505	·756	·023 7910	554
	·019 7974	460		·021 7268	506		·023 8464	556
·717	·019 8434	462	·737	·021 7774	507	·757	·023 9020	557
	·019 8896	463		·021 8281	509		·023 9577	559
·718	·019 9359	464	·738	·021 8790	509	·758	·024 0136	560
	·019 9823	465		·021 9299	511		·024 0696	561
·719	·020 0288	466	·739	·021 9810	512	·759	·024 1257	562
	·020 0754	467		·022 0322	513		·024 1819	564
9·720	·020 1221		9·740	·022 0835		9·760	·024 2383	

log ($e \sin \epsilon$)	log λ	
9·760	·024 2383	565
	·024 2948	567
·761	·024 3515	568
	·024 4083	569
·762	·024 4652	570
	·024 5222	572
·763	·024 5794	573
	·024 6367	575
·764	·024 6942	576
	·024 7518	577
·765	·024 8095	579
	·024 8674	580
·766	·024 9254	581
	·024 9835	583
·767	·025 0418	584
	·025 1002	585
·768	·025 1587	587
	·025 2174	588
·769	·025 2762	590
	·025 3352	591
9·770	·025 3943	592
	·025 4535	594
·771	·025 5129	595
	·025 5724	597
·772	·025 6321	598
	·025 6919	599
·773	·025 7518	601
	·025 8119	602
·774	·025 8721	604
	·025 9325	605
·775	·025 9930	607
	·026 0537	608
·776	·026 1145	609
	·026 1754	611
·777	·026 2365	612
	·026 2977	614
·778	·026 3591	615
	·026 4206	617
·779	·026 4823	618
	·026 5441	620
9·780	·026 6061	

log ($e \sin \epsilon$)	log λ	
9·780	·026 6061	621
	·026 6682	622
·781	·026 7304	624
	·026 7928	626
·782	·026 8554	627
	·026 9181	628
·783	·026 9809	630
	·027 0439	631
·784	·027 1070	633
	·027 1703	634
·785	·027 2337	636
	·027 2973	638
·786	·027 3611	639
	·027 4250	640
·787	·027 4890	642
	·027 5532	643
·788	·027 6175	645
	·027 6820	647
·789	·027 7467	648
	·027 8115	649
9·790	·027 8764	651
	·027 9415	653
·791	·028 0068	654
	·028 0722	656
·792	·028 1378	657
	·028 2035	659
·793	·028 2694	660
	·028 3354	662
·794	·028 4016	664
	·028 4680	665
·795	·028 5345	667
	·028 6012	668
·796	·028 6680	670
	·028 7350	671
·797	·028 8021	673
	·028 8694	675
·798	·028 9369	676
	·029 0045	678
·799	·029 0723	679
	·029 1402	681
9·800	·029 2083	

log ($e \sin \epsilon$)	log λ	
9·800	·029 2083	683
	·029 2766	684
·801	·029 3450	686
	·029 4136	687
·802	·029 4823	689
	·029 5412	691
·803	·029 6203	693
	·029 6896	694
·804	·029 7590	695
	·029 8285	698
·805	·029 8983	699
	·029 9682	700
·806	·030 0382	703
	·030 1085	704
·807	·030 1789	705
	·030 2494	707
·808	·030 3201	709
	·030 3910	711
·809	·030 4621	713
	·030 5334	714
9·810	·030 6048	715
	·030 6763	718
·811	·030 7481	719
	·030 8200	721
·812	·030 8921	722
	·030 9643	725
·813	·031 0368	726
	·031 1094	727
·814	·031 1821	730
	·031 2551	731
·815	·031 3282	733
	·031 4015	734
·816	·031 4749	737
	·031 5486	738
·817	·031 6224	740
	·031 6964	742
·818	·031 7706	743
	·031 8449	745
·819	·031 9194	747
	·031 9941	749
9·820	·032 0690	

log (e sin ϵ)	log λ		log (e sin ϵ)	log λ		log (e sin ϵ)	log λ	
9·820	·032 0690	750	9·840	·035 2146	825	9·860	·038 6744	908
	·032 1440	753		·035 2971	827		·038 7652	910
·821	·032 2193	754	·841	·035 3798	830	·861	·038 8562	912
	·032 2947	756		·035 4628	831		·038 9474	915
·822	·032 3703	757	·842	·035 5459	833	·862	·039 0389	917
	·032 4460	760		·035 6292	835		·039 1306	919
·823	·032 5220	761	·843	·035 7127	838	·863	·039 2225	921
	·032 5981	763		·035 7965	839		·039 3146	923
·824	·032 6744	765	·844	·035 8804	841	·864	·039 4069	925
	·032 7509	767		·035 9645	843		·039 4994	928
·825	·032 8276	768	·845	·036 0488	846	·865	·039 5922	930
	·032 9044	771		·036 1334	847		·039 6852	932
·826	·032 9815	772	·846	·036 2181	849	·866	·039 7784	935
	·033 0587	774		·036 3030	852		·039 8719	936
·827	·033 1361	776	·847	·036 3882	853	·867	·039 9655	939
	·033 2037	778		·036 4735	855		·040 0594	941
·828	·033 2915	779	·848	·036 5590	858	·868	·040 1535	944
	·033 3694	782		·036 6448	859		·040 2479	945
·829	·033 4476	783	·849	·036 7307	862	·869	·040 3424	948
	·033 5259	785		·036 8169	863		·040 4372	951
9·830	·033 6044	787	9·850	·036 9032	866	9·870	·040 5323	952
	·033 6831	789		·036 9898	868		·040 6275	955
·831	·033 7620	791	·851	·037 0766	870	·871	·040 7230	957
	·033 8411	792		·037 1636	871		·040 8187	959
·832	·033 9203	795	·852	·037 2507	874	·872	·040 9146	962
	·033 9998	796		·037 3381	876		·041 0108	964
·833	·034 0794	799	·853	·037 4257	879	·873	·041 1072	966
	·034 1593	800		·037 5136	880		·041 2038	968
·834	·034 2393	802	·854	·037 6016	882	·874	·041 3006	971
	·034 3195	804		·037 6898	885		·041 3977	973
·835	·034 3999	806	·855	·037 7783	886	·875	·041 4950	976
	·034 4805	808		·037 8669	889		·041 5926	978
·836	·034 5613	810	·856	·037 9558	891	·876	·041 6904	980
	·034 6423	811		·038 0449	893		·041 7884	983
·837	·034 7234	814	·857	·038 1342	895	·877	·041 8867	985
	·034 8048	816		·038 2237	897		·041 9852	987
·838	·034 8864	817	·858	·038 3134	899	·878	·042 0839	990
	·034 9681	820		·038 4033	902		·042 1829	992
·839	·035 0501	821	·859	·038 4935	903	·879	·042 2821	994
	·035 1322	824		·038 5838	906		·042 3815	997
9·840	·035 2146		9·860	·038 6744		9·880	·042 4812	

Ephemerides of the Satellites of Saturn, 1890–91. By A. Marth.

In the following ephemerides the five inner satellites are assumed to move in circular orbits in the plane of the ring, the ascending node N and inclination J of which, in reference to the plane parallel to the Earth's equator, are assumed to be

$$\text{for } 1891{\cdot}0, \quad N = 126^{\circ}{\cdot}7433\,; \; J = 6^{\circ}{\cdot}9802.$$

These and the corresponding values, adopted in my previous ephemerides, depend on a modification of Bessel's determination, which I had deduced, some thirty years ago, by taking into account the observed disappearances and reappearances of 1848–49, and by applying corrections to the computed places of *Saturn*, and also a correction pointed out by Beima ("De Annulo Saturni," p. 87). At the time I considered this modification as a merely preliminary one, which would be superseded a few years later, when advantage would have been taken of the favourable opportunities of the years 1861–62 for settling several questions concerning the ball and ring of *Saturn*, and especially whether there is any sensible deviation of the ring from the plane of *Saturn's* equator, in which case the effect would show itself in the observed position-angles of the ring, when it appears as a narrow ellipse. This expectation of thirty years ago having remained unfulfilled, it is high time that, at the end of another revolution of *Saturn*, these questions should be settled or substantial progress towards their settlement made, and it is to be hoped that the superior telescopes and micrometers now available will be devoted to observations of *Saturn* and its satellites during the next two apparitions of the planet.

In the following table P denotes the position-angle of the minor axis of the ring, L + 180° the planetocentric longitude of the Earth referred to the assumed plane of the ring, Λ + 180° that of the Sun or Λ − L the difference between the two. The last column contains the values of log $\nu = 0{\cdot}950 - \log \Delta$, the *Nautical Almanac* values of the distances Δ of the planet from the Earth being so altered as to take the equation of light into account.

Greenwich Noon.	P	L	Latitude of Earth | Sun above plane of Ring		Λ − L	log ν
1890.	°	°	°	°	°	
Oct. 29	354·600	166·631	−3·339	−5·692	−4·202	9·954275
Nov. 3	·635	167·039	3·140	5·615	4·452	·957224
8	·667	167·420	2·956	5·537	4·676	·960358
13	·697	167·773	2·789	5·460	4·872	·963661
18	·725	168·096	2·638	5·383	5·037	·967117
23	·750	168·387	2·505	5·305	5·170	·970704
28	·772	168·644	2·392	5·228	5·270	9·974402